# IN-HOUSE INTEGRATION OF SPACE PAYLOADS:

# CNES FACILITIES AND ACTIVITIES IN PROGRESS

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## ABSTRACT

The CNES Space Centre at Toulouse maintains a capability to perform in-house the assembly, integration and tests (AIT) of all kinds of complex payloads as well as of scientific micro satellites. To this aim, CNES operates six fully equipped ISO 7 class clean rooms. A team of engineers and technicians can cover in house all the AIT trades, for the development and operation of the ground support equipment and test benches, and for the organization and execution of the integration tasks.

Recently, the payloads of the CNES first scientific microsatellites, DEMETER and PARASOL, have been assembled and tested at CNES. The COROT instrument has also been integrated and qualified by the same teams, before delivery to THALES ALENIA SPACE for mating on the satellite bus.

Today, the payloads in process of integration at are the PICARD microsatellite, the PHARAO space clock engineering model, the SAPHIR instrument, and the CHEMCAM mast unit flight model. Preliminary work has also been done already on the MICROSCOPE satellite dummy, and TARANIS, SMESE or the SIMBOL X payload give attractive perspectives for the coming years.

This paper presents:

- the integration facilities and means available at CNES,
- the payloads in process of integration and the current progress status.

Plus it will be shown that integration activities on flight hardware is a valuable training field for young engineers fond of space sciences, and that CNES facilities and technical manpower can provide a fruitful support to the scientific laboratories for the space validation of their instruments.

## 1. CNES INTEGRATION AND TEST FACILITIES

The CNES technical centre provides six fully equipped clean rooms dedicated to the assembly, integration and test of varied space instruments and vehicles. Representing a total workspace of 700 m², all rooms can be operational 24 hours all year long, with a permanent monitoring of the ambient conditions: temperature, humidity, cleanliness class easily close to 10000 (ISO7). For cleanliness demanding activities, class 100 laminar flow benches can be used: for instance the integration of the very sensitive COROT telescope was achieved at CNES in 2005, under a 15 m3 clean tent (see fig.1)

Credit CNES: Fig. 1: integration of the COROT telescope at CNES

The main integration room offers a crane capacity of 3 tons, 250 m² workspace and 8 m height under ceiling: It is adequate to host big and heavy payloads, like the 2.8 tons PRONAOS gondola in the mid-90s, or several smaller payloads in parallel.

Fig. 2: the CNES main AIT Building

Adjacent to the clean rooms, five labs house electrical tests activities, a workshop for flight harness manufacturing or repairs, a mechanics workshop, one computer room and a storage area.

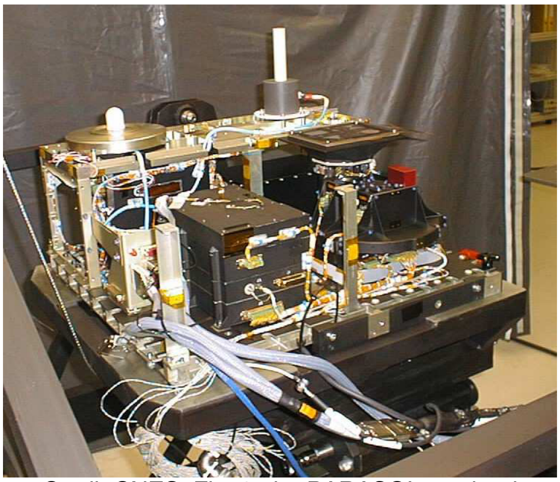
For the environmental qualification of the payloads flight models, CNES usually takes advantage of the vicinity of

Intespace (ITS), a company specialized in environmental testing.

## 2. THE AIT ACTIVITIES AT CNES: ORGANIZATION

### 2.1 The AIT context at CNES

CNES maintains a capacity and know-how for in house AIT of scientific innovative payloads. The instruments are delivered by the scientific labs or the industry, and the AIT at system level is performed by CNES staff (see the PARASOL payload example on Fig.3)



Credit CNES, Fig. 3: the PARASOL payload

Moreover, the decision was taken, in late 2004, to perform in-house the AIT of the scientific microsatellites of the MYRIADE line of product, described in [1]; for PICARD, for example, this activity is done entirely at CNES, with the support of an industrial team.

### 2.2 A valuable support to the scientific labs:

CNES implication on the side of the scientific laboratories to participate in the procurement of the ground means, and to prepare and perform the AIT activities, proves to be a winner to winner approach: the labs can thus concentrate on the scientific mission development and on the instruments performances.

An outstanding example of this process was the recent integration of the COROT telescope: CNES was responsible for the whole system and for the instrument, while Thales Alenia Space (TAS) was the Satellite industrial architect. Consequently, CNES has led the development and the AIT of the payload, with the scientific labs in charge of the subsystems, namely:

- The IAS (Orsay) and LESIA (the Paris-Meudon Observatory) for the camera
- The LESIA for the focal block and the electronic case
- The LAM (Marseille) for the performances of the instrument.

See [5] for more details about the COROT payload.

CNES engineers stayed several weeks at the labs premises to help in the preparation of the ground benches and test plans. On the other hand, members of the labs joined the integration team at CNES.

The same approach is in process, on the side of the Service d'Aéronomie of French CNRS, for the Picard payload.

It is assessed that acting as a prime in the development of some scientific space experiments, seems to be the most efficient way for CNES to manage the costs, planning and risk-performances budget. Finally, focusing on the AIT of small complex scientific payloads, CNES activity appears as complementary to the European space industry activities: industrial companies are more dedicated to the serial production of recurrent platforms, of commercial and application satellites and instruments.

### 2.3 A training field for young engineers

Being an actor in the manufacturing and testing of space hardware presents an attractive training field for the new comers at CNES.

The AIT activities offer a direct contact with flight equipment, and a complete view of the qualification tests to be run on a flight model before it complies with its mission in orbit. During the AIT phase, a very complete collaborative work is done gathering together the conception authorities, the architects, the scientists and the team in the clean room: such a technical and human adventure, lasting several months, gives a valuable experience to the participants. The young engineers will then fully understand the inter-dependence of all the actors, and be ready to play an effective part in the development of a complex space system.

### 2.4 Organization and methodology

AIT activities are performed at the end of one project development, just before, and during the launch campaign. At that final stage, there is no time for improvisation: all the procedures have to be prepared and all ground means procured and validated on time. Thus, the AIT preparation period is a key phase: it begins during the detailed design phase of the project, and requires exchanges between the project design authority (the project management, the architects and the scientific authority) and the integration team.

During the preparation phase, the design authority will write the development plan and the verification matrix, prerequisites for the elaboration of the AIT plan, a document that makes the synthesis of the following items:

– The required Ground Support Equipment (GSE)
– The AIT activities flow chart and schedule,
– The AIT team organization,

Then, the project architects and subsystems managers will issue the tests specifications, and the AIT team will verify that the proposed spacecraft layout and the tests required are feasible. The AIT procedures and ground means specifications will be prepared based on the input documents, as indicated in Fig.4.

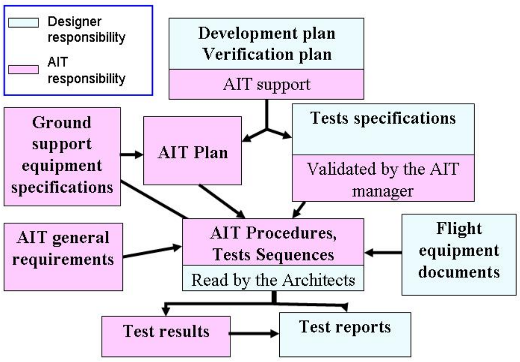



Fig. 4: the AIT documentation chart

When a procedure has been applied, the as runs and the test results are issued by the integration team. Based on these documents, the project architects will validate the results and authorize to go to the next operation step.

## 2.5 The integration team

The AIT team (at CNES) is basically composed of:

- The AIT manager leads the team: he is in charge of the interface with the conception authority; he is responsible for the preparation and achievement of the AIT plan, and of the integration planning.

During the integration phases, five different trades are involved in the process, and work in synergy:

– The mechanical integration team, develops or procures the mechanical and optics ground support equipment (MGSE including the handling and lifting devices, the integration dolly, the optical benches). These specialists achieve the mounting of the flight equipment on the spacecraft structure, perform the optical measurements, install the ground instrumentation before the environmental tests, place the thermal elements and the insulation covers on the spacecraft, and finalize its mechanical configuration for the launch.
– The electrical integration team, verify the interfaces of the flight equipment and make the interconnections with the harness.
– The functional validation team is in charge of the procurement and operation of the electrical ground support equipment (EGSE) and test benches (see fig.5).
– The logistics team, in charge of the preparation of the clean rooms, and of the organization of the spacecraft ground transportation, between the different test sites and to the launch site.
– The quality assurance team: the integration activities imply direct work on the flight equipment and therefore require special care from the quality assurance point of view. That is why the work in clean rooms and the related procedures need to be controlled by a dedicated quality insurance engineer.

Fig. 5: the EGSE for MYRIADE Micro satellites

## 2.4 The AIT flow chart

The integration and qualification sequence of a space payload generally consists in the following main chronological steps:

– Firstly, the integration preparation phase :
  - Preparation of the AIT plan
  - Procurement and validation of the GSE
  - Reception of the flight structure and harness
  - Reception of the flight pieces of equipment
– Secondly, the mechanical and thermal integration phase:
  - In clean room conditions, mounting of the structure walls,
  - Installation of the harness and of the thermal items (thermostats, thermistors, heaters, second surface mirrors),
  - mounting of the onboard equipment on the structure and verification of all the mechanical interfaces.
– Then, the electrical integration phase :
  - Verification of the electrical interfaces of all the flight instruments
  - Interconnection of the pieces of equipment through the flight harness
– The functional validation phase :
  - Installation of the EGSE, and mating to the flight system
  - Performance and reference tests: all performances are checked, for nominal and redundant chains. All functional modes can be tested. These tests are performed again after the environmental qualification, in order to verify that no degradation or drift affects the system.
  - Electrical compatibility tests,
– The environment qualification tests phase: their objective is to demonstrate the ability of the flight system to interface with the launcher, to cope with the launch phase loads, and to keep its performances during the orbit life. They include :
  - vibrations, shocks, acoustics solicitations,
  - thermal vacuum (VT) testing, with or without solar simulation (see Fig.7)

Credit CNES,
Fig. 7: COROT PL thermal vacuum at ITS

- The final tests phase: performances and flight-to-ground system tests (flight software, AOCS, end to end telemetry and telecommand tests).
- Finally the pre-launch phase:
  - Hardware configuration and software setup for the launch
  - Health-checking after transportation to the launch site,
  - And in the case of 'major' payloads, telemetry checking until launch.

After the launch, the integration team's job ends by the packing of the GSE, their shipment back to the integration site, and the reporting about the lessons learned. Then, they begin another project.

However, when the scientific mission centre is located at CNES, one AIT engineer can remain in charge of checking the payload control during the in orbit tests and orbit commissioning phases, and even later, to deal with scientific telemetry, in collaboration with the scientific team, for the instruction of in flight anomalies.

# 3 SOME ACHIEVEMENTS

One will find below some recent achievements performed in house CNES.

## 3.1 The DEMETER and PARASOL micro satellites : lessons learned

CNES develops as a main contractor the scientific microsatellites of the Myriade family (120 kg range). As far as the AIT activities are concerned, they are also done under CNES in house responsibility: by CNES specialists for the payloads, that are each time different and difficult to recurrently subcontract to the industry at no financial risk, and with the support of local industrial teams for integration of the bus and the satellite.

DEMETER and PARASOL have been the first CNES projects in the MYRIADE series. The satellites have been successfully operating in flight since 2004. Their payloads were fully assembled and validated at CNES. The satellites were integrated at LATECOERE premises in Toulouse.

The DEMETER mission (see [3] for details) was both scientific (study of the Earth seismic activity from space by five kinds of sensors, provided by 4 different laboratories) and technological (a mass memory, a high rate telemetry, an autonomous orbit control by GPS, a laser initiated pyrotechnical system, and new thermal coatings).

PARASOL is dedicated to the characterization of the radiative and microphysical properties of the clouds and aerosols, and their impact on the climate. The payload is composed of a single multispectral instrument simply derived from the POLDER imaging radiometer that previously flew aboard the ADEOS satellites.

Though DEMETER and PARASOL payloads largely vary by the number and origin of the instruments they are composed of, a common integration methodology was applied. The same ground validation benches could be used.

At platform and satellite level, the integration schedule of PARASOL retrieved significant benefit from the recurrence of the bus and system, the temporal and geographic proximity of the activities (done under the same roof by almost the same teams, at six months interval) and the systematic feedback from the DEMETER experience. The same ground support equipment (GSE) was used, the same procedures were applied and the number of anomalies could be drastically reduced.

The feedback from the DEMETER and PARASOL shows that, from the assembling of the bus structure to the shipment of the satellite to the launch site, a typical MYRIADE integration campaign lasts round 18 months. An AIT preparation period of about 6 months is needed for a recurrent bus, and sometimes much longer for the payload: the CNES AIT team may have to discuss quite in advance with the scientific laboratories, providers of the instruments, to anticipate the validation critical points and organize an adequate collaborative support.

## 3.2 The COROT telescope

The COROT space telescope, equipped with a 4-CCD wide-field camera, and put aboard a PROTEUS platform was successfully launched in December 2006. The satellite is in the 600 kg range. The project was led by CNES, in cooperation with several French laboratories and several partner countries (Europe, Brazil). COROT is a precursor in two astrophysical fields:

- The detection and the study of stars vibrations (stellar seismology).
- The search for extra solar planets and more particularly the telluric planets.

The telescope requires very accurate temperature stability, better than 0.05℃/hour.

The CNES was responsible for the whole system and for the instrument, while Thales Alenia Space (TAS) was the Satellite industrial architect. Consequently, CNES has led the development and the AIT of the payload, in close collaboration with the scientific labs in charge of the subsystems, namely:

- The IAS (Orsay) and LESIA (the Paris-Meudon Observatory) for the camera
- The LESIA for the focal block and the electronic case
- The LAM (Marseille) for the performances of the instrument.

See [5] for more details about the COROT payload.

The payload has been assembled and qualified by CNES and delivered to TAS. At satellite level, the CNES AIT team has been present at TAS premises at Cannes at each validation step on the instrument, and participated in the pre-launch tests and final configuration settings during the launch campaign at Baïkonur.

## 4 TODAY IN CNES CLEAN ROOMS

This paragraph gives an overview of the new projects in process of integration at CNES premises:

### 4.1 The PHARAO atomic space clock

The PHARAO project consists in developing a new generation of clocks in space, taking advantage of two factors: the very low temperatures obtained by laser cooling techniques, and the micro-gravity environment of satellites in Earth orbit. These two factors enhance the clock performance, expected to yield a stability of 10^(-16) s on a period of several days.

The objectives of PHARAO, listed below, ally fundamental physics and technical challenges:

- To operate, for the first time in space, a laser cooled caesium clock in micro-gravity,
- To distribute by radio the optimised time scale of PHARAO, to ground users.

The PHARAO instrument consists of four sub-systems: a caesium tube (TC), a Laser Source (SL), a microwave source (SH) and a control system (UGB).

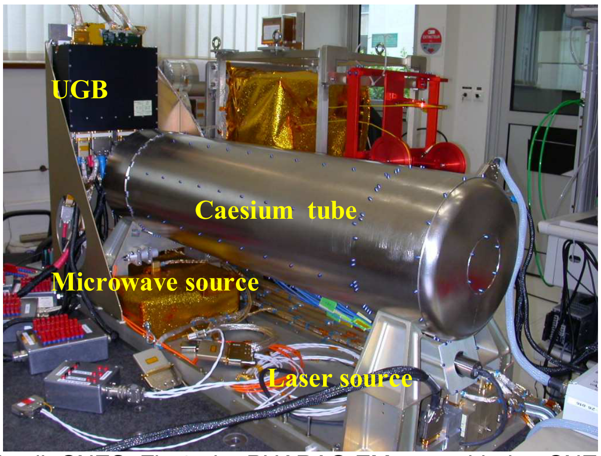
The industry delivers the subsystems, CNES is the prime contractor for PHARAO, and the AIT activities are performed in house. As the manufacturing of the subsystems and the integration and qualification of the space clock constitute a mere challenge, an EM (engineering model) approach was adopted.

Step by step, the GSE have been procured, the EM parts have been received at CNES for integration and performance testing. In April 2006, the first mating between the laser source and the caesium tube optical fibres was performed. The first cold atoms were obtained and, with a microwave source, the first Ramsey fringes. The results have shown a very satisfactory behaviour of the assembly.

At the date of writing this paper, the Engineering Model (EM) has been fully assembled (see Fig.8) and the full functional tests will be done beginning by September 2007. The system seems now mature enough for a go decision on the flight model. Due to financial issues, the possibility to develop PHARAO FM as part of the ACES mission of ESA, on board the ISS still needs confirmation.

Due to the complexity of the payload, the AIT activities are necessarily deeply involved in the development steps and the PHARAO AIT is split into 2 phases:

- The first AIV phase (AIV1) is dedicated to the functional validation of PHARAO, and of the sub-assemblies. For the EM, AIV1 is intended to validate the general design in order to authorize the manufacturing of the flight sub-assemblies.
- The second test campaign phase (AIV2) is dedicated to verifying the performances of the PHARAO clock.



Credit CNES, Fig.8: the PHARAO EM assembled at CNES

### 4.2 The PICARD and MICROSCOPE microsats

PICARD and MICROSCOPE, forming the second batch of MYRIADE microsatellites to be developed under CNES in house responsibility, will be entirely assembled and tested at CNES premises. The AIT engineering has begun since the definition phase of the projects, and all efforts are made to take benefit of the DEMETER and PARASOL feedback.

#### 4.2.1 The PICARD mission and payload

PICARD is dedicated to the simultaneous measurement of the solar irradiance and diameter, to study the influence of the solar activity on the climate of the Earth. The Picard mission needs to be in flight at a certain period depending on the solar activity phase, and the launch slot is foreseen by the first half of 2009.

The PICARD payload is composed of the following instruments (see Fig.9):

- SOVAP, a differential radiometer to measure the total solar irradiance, provided by the IRM of Belgium,
- PREMOS, a set of 3 photometers to study the ozone formation and destruction, and to perform helioseismologic observations, procured by the PMOD of Switzerland.
- SODISM, an imaging telescope accurately pointed and a CCD to measure the solar diameter and shape with an accuracy of a few milliarcs second, and to perform helioseismologic observations to probe the solar interior.
- A payload computer (PGCU), that will interface with the Myriade bus.

SODISM and the PGCU will be delivered to CNES by the Service d'Aéronomie (SA) of the French CNRS.

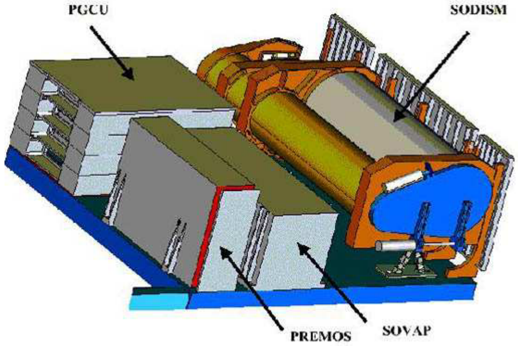


Figure 9: the PICARD payload

#### 4.2.2 The PICARD AIT status:

Year 2006 was dedicated to the preparation of the GSE, adapted from the MYRIADE GSE pool available at CNES and to the writing of the platform integration procedures.
Today, the bus mechanical and thermal integration phase has been achieved. Almost all the onboard equipment have been mounted and electrically tested (see Fig.10)

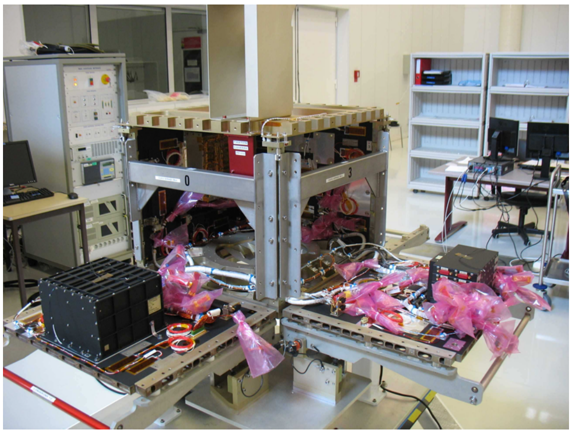


Fig. 10: integration of the PICARD platform

Due to the complexity of the instruments, the payload is still in process of development, and a close collaborative work has begun between CNES, and the labs to secure the payload AIT planning. The CNES architects and integration specialists are working with the SA architects: thus, the instruments hardware, the tests specifications and the AIT procedures should be available on time.
It must be mentioned that a special care will be taken to the cleanliness conditions during all the AIT work in presence of the payload, the sensitive optics of which require very low particular and molecular contamination. The payload integration at CNES will be done under an ISO 5 clean tent, and a continuous nitrogen flushing on the optics is foreseen.
The payload instruments should be delivered to CNES from the end of 2007 to March/April of 2008, and the satellite AIT phase should begin on the second quarter of 2008, allowing the launch before mid 2009.

#### 4.2.3 The MICROSCOPE mission and payload

MICROSCOPE (MICROSatellite à traînée Compensée pour l'Observation du Principe d'Equivalence) is dedicated to a fundamental physics experiment. The main scientific objective is the test of the Equivalence Principle with an accuracy of one hundred times better than the one obtained with experiments realised on Earth. The secondary objective is the making of an attitude control and drag free system using new micro-thrusters, which constitute a preliminary condition to perform the measurement of the Equivalence Principle.
The platform will host standard equipment from Myriade microsats and also integrate new instruments and special functions for this mission.
The payload, in process of development at French ONERA, is installed at the centre of the satellite to secure the feasibility of the mission, and is formed by:

- A T-SAGE instrument made of two independent differential accelerometers, each possessing a mechanical module and a control electronic unit,
- A structure equipped of thermal protection which holds the sensitive units and maintains a constant temperature.

The whole satellite box has a mass of 200 kg with dimensions much larger than those of the other Myriade satellites: 0.9 m x 0.9 m x 1.3 m
The system and the satellite architecture and development (including AIT) are under the CNES in house responsibility.

#### 4.2.4 The MICROSCOPE AIT status:

On the Microscope project, the AIT engineering team has been involved in the project since the early phases of payload and satellite design. Preliminary work has been done already:

- preparation of the payload and satellite AIT plans and organization
- work on a mock-up to define the layout of the flight harnesses (see Fig. 11),
- preliminary design of the GSE.

But due to the technical complexity of the mission, the validation of innovative parts, like the micro-thrusters, drives the development planning, and the AIT engineering has been put on standby waiting for a fixed layout and mature definition of the satellite. AIT work should resume on the project in 2008.

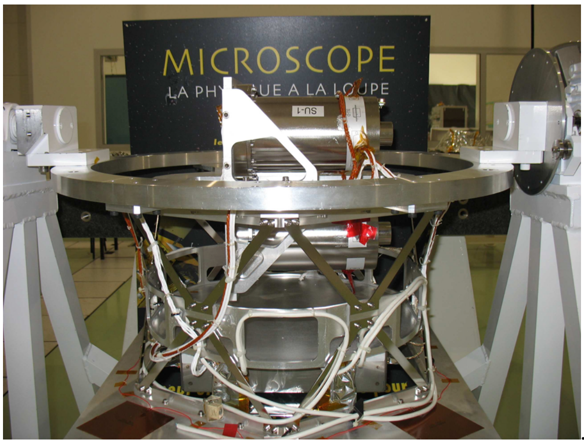



Fig.11: Mock-up of the Microscope core and harness

### 4.3 SCARAB and SAPHIR

#### 4.3.1 An overview of the instruments

These instruments will contribute to the mission of MEGHA-TROPIQUES, a mini-satellite using an Indian platform (IRS). Its payload is constituted of:

- MADRAS : a microwave imager aimed mainly at studying precipitation and clouds properties,
- SAPHIR (Sondeur Atmosphérique du Profil d'Humidité Intertropicale par Radiométrie): a microwave radiometer for the retrieval of water vapour vertical profiles and horizontal distribution; the water vapour vertical profile is obtained from 6 brightness temperatures integrated on 6 different channels

located close to the water vapour absorption line at 183.31 GHz.
SAPHIR is composed of a structure, a harness, an antenna unit including the reflector, the shroud, the onboard calibration target, the scanning mechanism (see Fig. 12) and the horn, plus an electronic unit (signal processing and power supply).

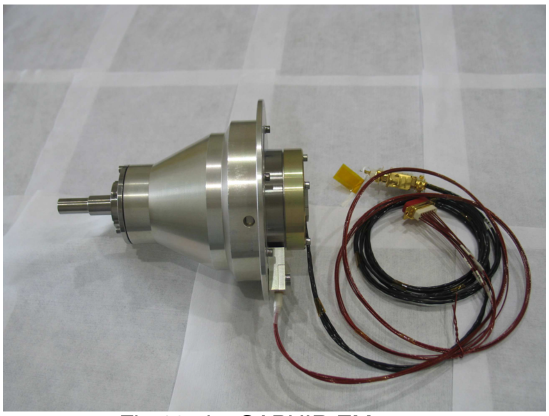


Fig.12: the SAPHIR EM scan

- SCARAB (SCAnner for RAdiative Budget)

(see Fig.13) : a radiometer devoted to the measurement of outgoing radiative fluxes at the top of the atmosphere, already qualified in orbit.
Scarab is a four channels radiometer (visible, solar, total and infrared), made to measure the Earth's Radiation Budget. This scientific instrument was developed by CNRS (LMD) and CNES. The model dedicated to MEGHA-TROPIQUES needs a complete refurbishment and calibration.

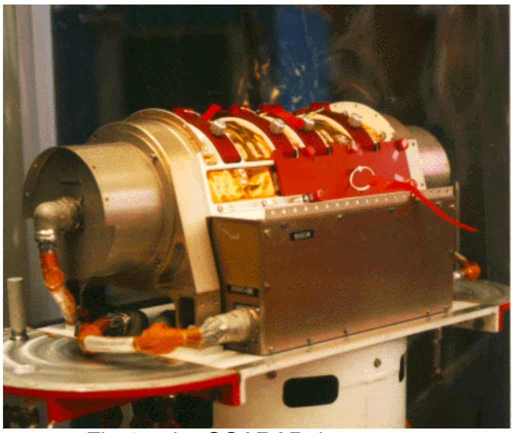


Fig.13: the SCARAB instrument

CNES is in charge of the instruments development, AIT, qualification and delivery to ISRO for mounting on the MEGHA TROPIQUES bus.

### 4.3.2 SCARAB and SAPHIR AIT status:

It must be noted that the integration activities on SCARAB and even more so on SAPHIR are deeply involved in the development, manufacturing and qualification process at instrument level. For SCARAB, the activities will be performed in collaboration with the scientific lab LMD of CNRS.
For instance, CNES integration mechanics will participate in the assembling of the mechanisms of SCARAB and SAPHIR. A training phase has begun on the engineering model of SAPHIR before the operation on the flight model. Moreover, CNES is in charge of the assembly and test of the SAPHIR RF unit package and of the calibration of the instrument: this includes the definition of the test bench and the design of a hot load.
Today the AIT plans have been completed by CNES, the test benches manufacturing is in progress, and a dedicated clean room is operational at CNES. The SAPHIR FM assembling is to begin in early 2008.

### 4.4 The T2L2 experiment

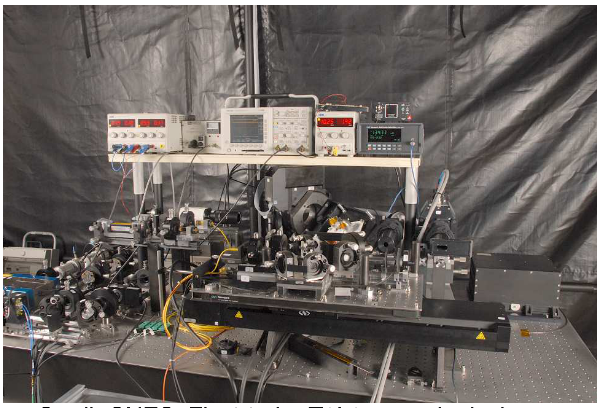
Jointly developed by the OCA (Observatoire de la Côte d'Azur) and CNES, T2L2 aims at time transfers by laser links. It is part of the JASON 2 payload, in progress of integration at TAS premises, and foreseen to be launched in June 2008. The instrument will permit the synchronization of remote clocks, located round the Earth. It will also monitor the reference clock onboard the JASON 2 payload, based on the DORIS 10 MHz oscillator.

#### 4.4.1 An overview of the instrument

The principle of the instrument relies on the propagation of light beams between the clocks to synchronize. The role of T2L2 onboard is to detect and date the occurrence of the laser shots transmitted from the ground telemetry stations. T2L2 weighs 10 kg and consumes 48 W.
The optics subsystem is composed of two boxes, mounted on a plate equipped with the active thermal control devices. It is located outside the payload module, at the extremity of a mast, and oriented towards the Earth.
The electronics box is located inside the JASON 2 payload module, on the same wall as DORIS, and linked to this latter instrument by the 10 MHz signal cable.

#### 4.4.2 The T2L2 AIT status

The T2L2 electronic unit has been manufactured by EREMS, a small company close to Toulouse. The optical box was procured by SESO, close to OCA. Further to the project CDR review, it was decided to perform the metrological performance tests of T2L2 at CNES, mainly to secure the cleanliness conditions: a dedicated area, under an ISO 5 clean tent, was organized at CNES, to host the very sophisticated optical test bench operated by the scientists of the OCA.
All security items were also deployed (blinking light, special laser protections) to authorize the laser shots under the tent (see Fig.14).



Credit CNES, Fig.14: the T2L2 metrological tests

A fruitful cooperation settled down between the scientists of OCA, the CNES instrument manager, the EREMS

representatives and the CNES AIT specialists: their collaborative efforts conducted to successfully perform the calibration and performance checking of T2L2, in due time, once having corrected several unforeseen anomalies.
T2L2 has now been mounted and tested on the JASON2 payload plate at TAS premises, and is ready for the environment testing at satellite level.

### 4.5 The CHEMCAM project

The ChemCam mast unit (MU), is part of the ChemCam Project conducted by the Los Alamos National Laboratory (LANL, USA). This instrument is part of the Mars Science Laboratory (MSL 09), a scientific payload integrated to a Rover, developed by JPL, which will travel on the surface of Mars for a 2 Earth years mission.
The schedule is very tight, as the launch opportunities to Mars only occur every second year: next slot is on September 2009 and can't be missed. Driven by this planning, the delivery of the MU flight model is expected no later than January 2008.
The development is a joint effort of several French laboratories, under CESR leadership (CESR, OMP, LATT) and CNES.
The cooperation between the "French" project and the "US" project (LANL at Chemcam Level, JPL at Rover level) is more similar to an integrated project team than to a "customer-supplier" relationship. The issues are assessed and solved together in a context of scientific project: the tests that could be critical for the schedule are shared or delayed at system level.

#### 4.5.1 An overview of the instrument

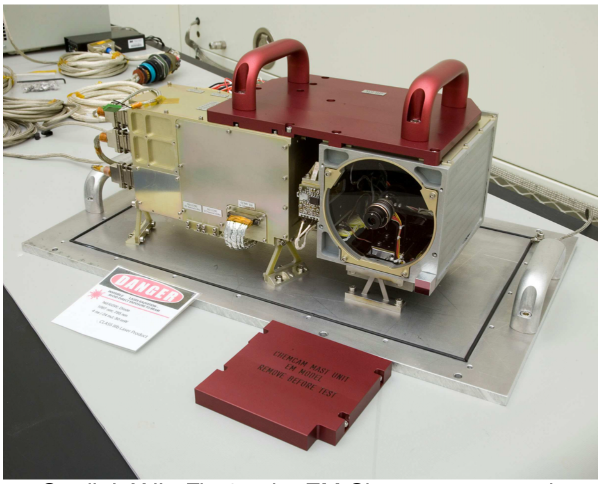
CHEMCAM (CHEMistry CAMera) is a spectrometer for analyzing the light coming from a plasma, created by a laser shot on Mars rocks, at a distance up to 10 meters.
The instrument is composed of two subsystems, linked by electrical cables and optical fibers:

- The « Mast Unit » (mounted on the rover mast): a laser source, a telescope, an RMI camera (Remote Micro Imager, an heritage of the Rosetta project) and the electronics associated: the MU is procured by the CESR.
- The « Body Unit »: a visible and ultraviolet spectrometer, its power unit and a control unit, procured by the LANL.

CHEMCAM will permit the elementary analysis of the composition of Martian rocks and soil.

#### 4.5.2 The CHEMCAM AIT status

The 'integrated' CESR-CNES AIT team, supported by the architects, have succeeded until now in meeting the very demanding schedule:
In spring 2007, they performed the assembling, full testing (functional, thermal, EMC) and delivery of the EM (engineering model) to the LANL (see Fig.15).



Credit LANL, Fig.15: the EM Chemcam mast unit

Now, the main challenge begins: the QM and the FM have to be assembled and tested in 6 months!
The following tasks will be done in parallel on the different models:
- support to LANL at Los Alamos, then at JPL for the integration and test of the EM-Mast Unit with Chemcam EM-Body Unit.
- assembly, qualification tests of the QM (functional, performance, EMC, mechanical, thermal vacuum),
- assembly, acceptance tests (functional, EMC, mechanical, thermal vacuum), and delivery of the FM to LANL.

To secure the cleanliness conditions round the instruments, the AIT activities on QM and FM will take place at CNES premises.

## 5 CONCLUSION

The CNES maintains the manpower, organization and infrastructures to perform the in house integration of all kinds of innovative and complex scientific payloads. All the more so as the AIT teams, the architects and the onboard equipment managers are now gathered together in the same directorate of the technical centre.
Several recent outstanding achievements like the COROT telescope, the DEMETER and PARASOL payloads, the T2L2 instrument, prove that in house AIT of subsystems is a field where the French space agency has a real added-value, on the side of the scientific community.
New challenges are today in progress in CNES clean rooms, namely the PICARD micro satellite, the PHARAO EM space clock, the SCARAB and SAPHIR instruments. Soon MICROSCOPE is expected to join the assembly room, and TARANIS, now in phase B, has already prebooked an integration area.
No doubt that these in house activities will generate valuable technical and human experiences, providing young engineers and more experienced ones, with an exciting operational field.

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